Report as of FY2008 for 2008VT32B: "Treatment Solutions to Reduce Nutrient and Bacterial Inputs to Lake Champlain at Shelburne Farms"

Publications

- Articles in Refereed Scientific Journals:
    - ♦ Lovell, S. Taylor, Johnston, D.M. Creating multifunctional landscapes – How can the field of ecology inform the design of the landscape? Frontiers in Ecology and the Environment. In press. Online: http://www.esajournals.org/archive/1540-9295/preprint/2009/pdf/10.1890_070178.pdf
    - ♦ Taylor Lovell, S., Sullivan, W.C. 2006. Environmental benefits of conservation buffers in the United States: Evidence, promise, and open questions. Agriculture, Ecosystems & Environment 112(4):249-260.
    - ♦ Sullivan, W.C., Anderson, O.M., and Taylor Lovell, S., 2004. Agricultural buffers at the rural-urban fringe: an examination of approval by farmers, residents, and academics in the Midwestern United States. Landscape and Urban Planning 69:299-313.
    - ♦ Taylor-Lovell, S., Sims, G.K., and Wax, L.M. 2002. Effects of moisture, temperature, and biological activity on the degradation of isoxaflutole in soil. Journal of Agricultural and Food Chemistry 50:5626-5633.
    - ♦ Taylor-Lovell, S., Sims, G.K., Wax, L.M., and Hassett, J.J. 2000. Hydrolysis and soil adsorption of the labile herbicide isoxaflutole. Environmental Science and Technology 34:3186-3190.

Report Follows

Title: Treatment Solutions to Reduce Nutrient and Bacterial Inputs to Lake Champlain at Shelburne Farms

Rationale:

Agricultural runoff in the Lake Champlain basin has long been recognized as a major water quality problem that threatens the ecological health and human uses of the lake. Point and non-point source pollution from farms can carry excess nutrients and other pollutants to downstream aquatic ecosystems and can create a variety of problems including toxic algal blooms, fish kills, loss of biodiversity, beach closures, and increased human health risks. Shelburne Farms is a 1400-acre grass-based dairy, a national historic landmark, and a non-profit environmental education center situated on the eastern shores of Lake Champlain. With their proximity to the lake and strong commitment to agricultural and natural resource stewardship, Shelburne Farms is eager to ensure that their agricultural practices do not negatively impact water quality. However, water quality monitoring in recent years has shown that unacceptably high concentrations of nutrients and bacteria are present in agricultural runoff during summer storms. To minimize agricultural pollutants from entering the lake, Shelburne Farms has decided to install a vegetated treatment system designed to intercept and treat runoff from the dairy barnyard area. Our research at Shelburne Farms will focus on evaluating the performance of the vegetative treatment system in mitigating agricultural pollutants during the startup phase of the system. We will also investigate whether the use of this technology is appropriate on sixteen selected dairy farms in the Champlain Valley.

Goals:

The goals of this project are to characterize the quality of surface water resources at Shelburne Farms, to design an innovative and cost-effective treatment system to improve water quality, and to monitor the performance of the treatment system once it has been installed. We will monitor influent and effluent water quality for Total Dissolved Phosphorus (TDP), Total Phosphorus (TP), Total Suspended Solids (TSS) and *E. coli*. We will also investigate whether the use of this technology is appropriate on sixteen selected dairy farms in the Champlain Valley.

Progress to Date:

Hisashi Kominami, a M.S. student in the Plant & Soil Science Department, has been responsible for collecting data and performing the research for this project. Water quality was monitored during seven summer rain events in 2008 to characterize pollutant concentrations in agricultural stormwater. During each of the sampling events, replicate grab samples were collected for the eleven sampling sites (when applicable) and then tested for the following parameters: total phosphorus (TP), dissolved reactive phosphorus (DRP), total suspended solids (TSS), and E. coli. Monitored sites included two in-lake and nine in-stream sampling sites. A map showing sampling site locations and descriptions is found below as well as results obtained from monitoring in 2008.

2008 Sampling Sites at Shelburne Farms

Lake Champlain

NPB

OPB

ES, ESL

DBM

DB

BHS

MGR

OCCP

Compost Piles

SBN, SBS

0   550   1,100   2,200   3,300
Feet

● **Sampling Sites**
— **Streams**

N

| Abbreviation	Sampling Site Name*	Site Sampling Description
NPB	North Pasture Beach	Stream outflow sampling
OPB	Orchard Point Beach	Lake sampling
BHS	Butternut Hill Stream	Stream sampling
DBM	Dairy Barn Manure	Drainage ditch sampling
DB	Dairy Barn	Drainage ditch sampling
ES	Elm Swamp	Wetland outflow sampling
ESL	Elm Swamp Lake	Lake sampling
MGR	Market Garden Road	Drainage ditch sampling
OCCP	Orchard Cove/Compost Pile	Outflow sampling
SBN	South Beach North	Outflow sampling
SBS	South Beach South	Outflow sampling

Average DRP & TP for Sampling Sites at Shelburne Farms (2008)

Average Total Suspended Solids (2008)
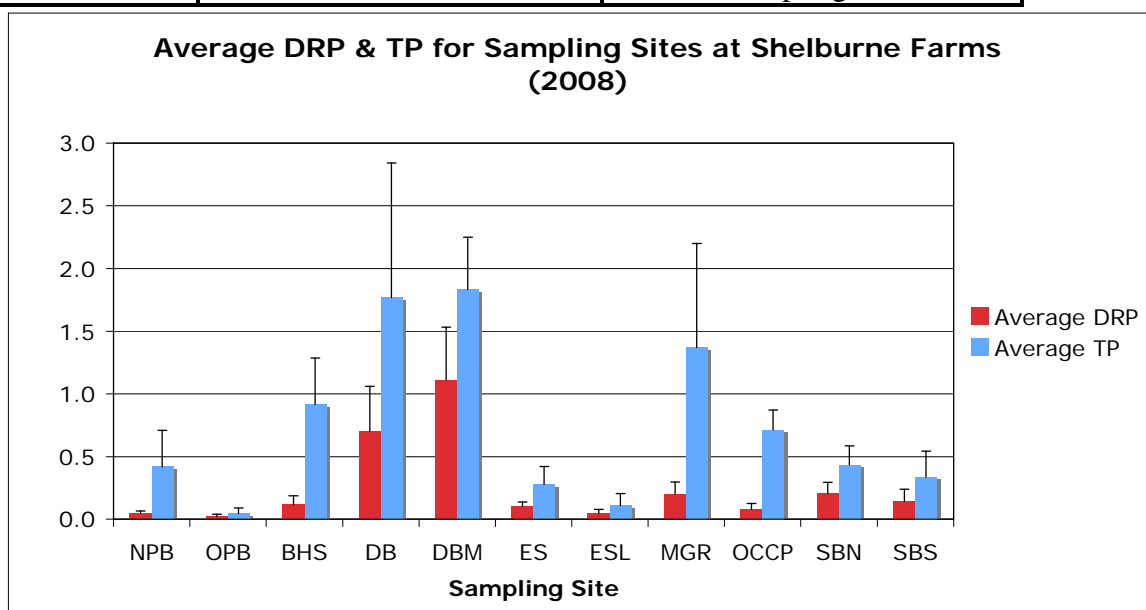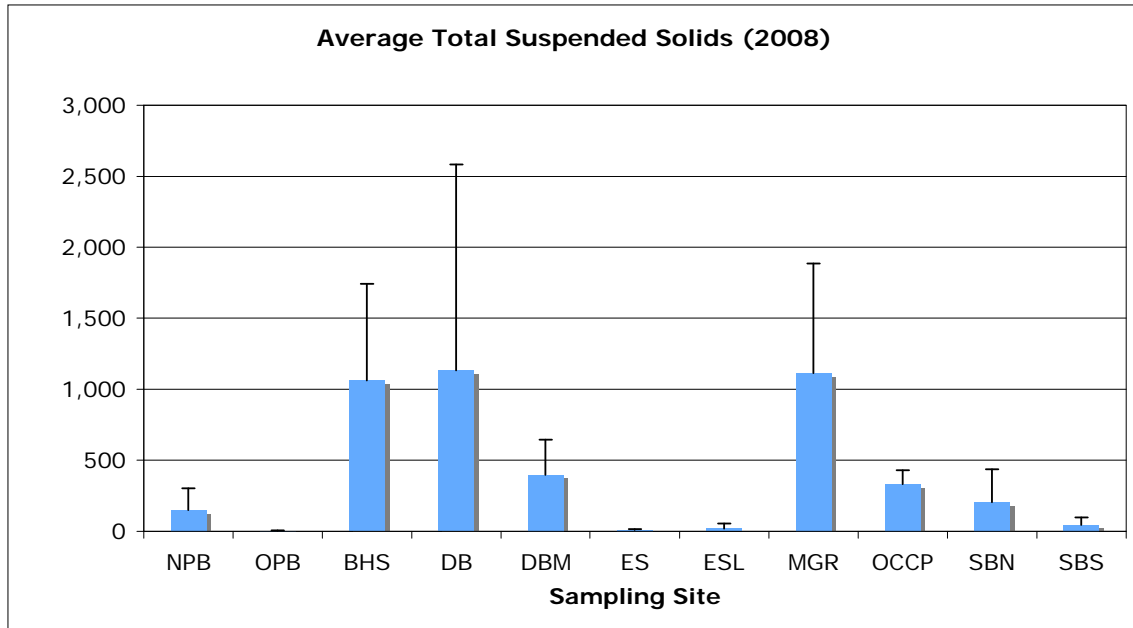
Monitored Swimming Beaches		
Sampling Date	**Orchard Point Beach**	**Elm Swamp Lake**
7/3/08	133	649
7/9/08	44	285
7/13/08	5	62
7/18/08	80	435
7/20/08	>2419	2419
7/24/08	10,462	9208
8/2/08	93	1986

Monitored Outflows & Drainages									
Sampling Date	**NPB**	**BHS**	**DB**	**DBM**	**ES**	**MGR**	**OCCP**	**SBN**	**SBS**
7/3/08	>2,419	1,414	22,210	98,040	1,553	71,700	68,670	>2,419	1,300
7/9/08	24,890	20,867	488,400	1203,300	10,462	NA	241,920	NA	6,131
7/13/08	384	2,909	48,840	209,800	1,986	NA	111,990	NA	291
7/18/08	413	15,531	27,230	173,290	3,873	92,080	36,540	NA	24,192
7/20/08	1,043	2,419	235,900	547,500	12,997	7,030	9,600	2,187	1,785
7/24/08	24,192	111,990	579,400	613,100	17,329	9,330	9,090	4,352	4,884
8/2/08	14,136	81,640	90,900	248,100	225	32,550	17,329	141,360	141,360

In addition to the monitoring effort, our research team consulted with an ecological engineer (David Whitney, EcoSolutions) and a watershed scientist (Evan Fitzgerald) to assess the hydrology of the dairy barnyard site and develop an ecological stormwater design. Subwatersheds were delineated and categorized based on the level of nutrient loading, in order to prioritize the treatment objectives. Initially, three systems were recommended to treat different areas of the site: a free water surface constructed wetland, a gravel wetland filter, and a bioretention system. Further analysis of the site, however, revealed the presence of a Class III wetland in the area where the free water surface constructed wetland was proposed. An alternative design was proposed, using a weir to control flow through a culvert, to take advantage of the treatment capacity of the existing Class III wetland (see figure next page). In addition, a vegetated gravel wetland was proposed for treating water prior to entering the Class III wetland. This design has been approved by the stakeholders and will be installed in early June. Once completed, Hisashi Kominami will assess the performance of the system in mitigating agricultural pollutants.

Proposed design for vegetated gravel wetland and discharge weir.
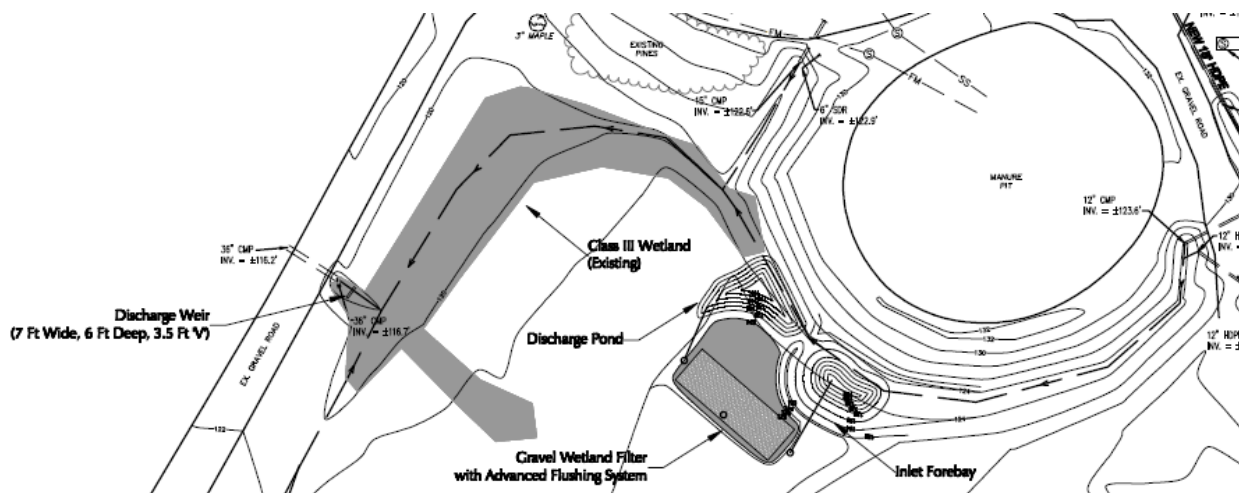
Water quality monitoring data collected at Shelburne Farms since 2004 was synthesized into a technical report and presented to Shelburne Farms stakeholders including the residents living near Shelburne Farms, the Shelburne Farms Water Quality Working Group, and the Shelburne Farms Board of Directors. A presentation of the 2008 summer sampling was also prepared for the Shelburne Farms board members.

This project received a second year of funding, so it will continue through February 28, 2010. As final tasks, we will complete research to assess performance of the agricultural stormwater treatment system and investigate the appropriateness of using this technology on sixteen dairy farms in the Champlain Valley. This research will comprise the bulk of Hisashi Kominami's MS thesis project. We will also coordinate outreach opportunities to educate the public about protecting water quality in Vermont's agricultural landscapes.